

Diffuser Calibration Facility

Goddard Space Flight Center

NASA

Scatterometer Angular Convention and Data File Format

In order to understand the scatterometer data file format, one must first understand the angular convention adopted in the operation of the scatterometer. The scatterometer is operated according to the beam coordinate convention shown in Figure 1. In this figure, a Cartesian coordinate system is setup on the sample at the point of illumination to identify positions on the sample. The incident elevation angle, θ_i , is measured from the sample normal (i.e. sample z axis) and can assume values of 0 to 180 degrees. The sample normal is at θ_i equal to 0 degrees. The incident azimuthal angle, ϕ_i , is measured from the positive sample x axis and is by definition is always equal to 180 degrees. The scatter elevation angle, θ_s , is measured from the sample normal (i.e. sample z axis) and can assume values of 0 to 90 degrees for reflectance measurements and 90 to 180 degrees for transmittance measurements. The sample normal is at θ_s equal to 0 degrees. The scatter azimuthal angle, ϕ_s , is measured from the positive sample x axis and can assume values of -180 to +180 degrees. The positive x axis is located at ϕ_s equal to 0 degrees.

The data files directly obtained from the NASA DCAF scatterometer follow the reporting format outlined in the 1991 ASTM Standard E1392-90 entitled, "A Standard Practice for Angle Resolved Optical Scatter Measurements on Specular or Diffuse Surfaces" [1]. The file format of the data provided to users is provided in Table 1 below. An explanation of the data file content follows.

Table 1. Scatterometer Data File Format

1. Date: xx-yy-zz
2. Sample Comments:

Sample name/number
Responsible institution
Sample material
Sample size
Visible state of sample optical surface

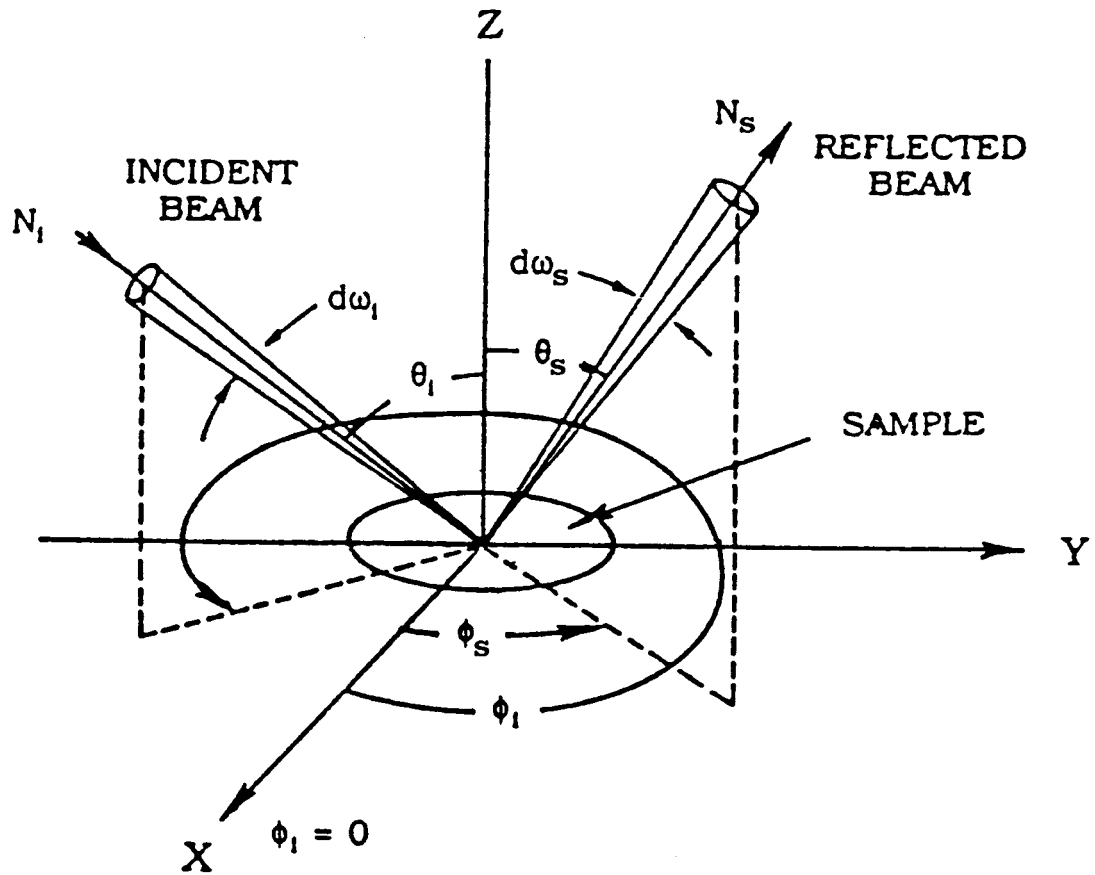


Figure 1

3. Scatterometer Settings:

Source employed
 Detector employed
 Type of scan
 Polarization status of scan

4. Wavelength
5. Incident angles
6. Scatter angles

7. Scatterometer raw data filenames
8. Data

BRDF (sr-1) Theta i Theta s Phi i Phi s Spot x Spot y

9. Additional comment

Line 1: The date that the data were obtained. The format for the date is xx=day of the month, yy=month of the year, zz=last two digits of year.

Line 2: These are comments on the sample measured. The name and serial number (if available) of the sample is recorded along with the institution to which the sample belongs. The sample material is identified along with a description of its shape and dimensions of its size. Lastly, the results of a visible inspection of the sample are provided.

Line 3: This is a description of the scatterometer setting used in acquiring the data. The source is identified as the broadband + monochromator, the He/Ne laser, or the He/Cd laser. The detector is identified as either the silicon photodiode or the photomultiplier tube detector. The type of scan is identified as standard BRDF, cosine-corrected BRDF, standard BTDF, cosine-corrected BTDF, BRDF raster scan, BTDF raster scan, or total hemispherical reflectance (THR) scan. The polarization state of the incident light is specified as unpolarized, s-, or p-polarized.

Line 4: This is the wavelength of the incident light in nm.

Line 5: These are the incident angles used in the scan. Fixed angles or scanned angular ranges are indicated for the incident elevation angle, θ_i , and the incident azimuthal angle, ϕ_i ,

Line 6: These are the scatter angles used in the scan. Fixed angles or scanned angular ranges are indicated for the scatter elevation angle, θ_s , and the scatter azimuthal angle, ϕ_s .

Line 7: These are the raw data filenames created by the scatterometer data acquisition system.

Line 8: The scatter data is provided in columnar format. BRDF or BTDF is in units of sr-1; the incident elevation and azimuthal angles, theta i and phi i, and the scatter elevation and azimuthal angles, theta s and phi s, are in units of degrees. For raster scans, the x and y coordinates of the scatter measurement are in units of millimeters.

Line 9: Additional comments are provided.

References

[1] ASTM Standard E1392-90, "A Standard Practice for Angle Resolved Optical Scatter Measurements on Specular or Diffuse Surfaces" (1991).